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Photovoltaics Program
Technology Development and Applications
Lead Center

Photovoltaic System Criteria Documents

Volume VI: Criteria for Auditing Photovoltaic System Applications and Experiments

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SECTION I

INTRODUCTION

A. PURPOSE

This document defines the criteria for auditing photovoltaic system applications and experiments. The purpose of the audit is twofold:

(1) To see if the application is meeting its stated objectives and

(2) To measure the application's progress in terms of the National Photovoltaic Program's goals of performance, cost, reliability, safety, and socio-environmental acceptance.

The information obtained from an audit will be used to assess the status of an application and to provide the Department of Energy with recommendations on the future conduct of the application.

B. SCOPE

This document covers those aspects of a site audit necessary to produce a systematic method for the gathering of qualitative and quantitative data to measure the success of an application. A sequence of audit events and guidelines for obtaining the required information is presented.

C. APPROACH

Audits will be initiated by the Test and Applications (T&A) function of the Technology Development and Applications (TD&A) Lead Center with the concurrence of the cognizant field center. Responsibility for gathering the audit information will be with the field center. Upon receipt of the audit information, TD&A will prepare an audit report in cooperation with the field center. This report will provide the basis for assessing the experiment.

D. APPLICABILITY

Operational audits will typically be performed on operational photovoltaic systems. Preliminary or special audits may occur at any phase of project development.

E. DOCUMENT ORGANIZATION

The body of this document contains two sections. Section I contains the introduction, and Section II defines the audit requirements. The appendixes contain audit data worksheets. These are to be used for recording the required audit information. The cognizant field center manager is responsible for overseeing completion of the worksheets.

SECTION II

AUDIT REQUIREMENTS

A. EXPERIMENT/APPLICATION DESCRIPTION (APPENDIX A WORKSHEETS)

1. General

An essential first step in any audit is to gather information on how the manager of an application perceives and controls his responsibilities. The appendix worksheets are arranged in a one-to-one correspondence with the topics in this section.

2. Objectives (Appendix A, Paragraph A)

Briefly state in specific terms what the application is supposed to accomplish; i.e., goals, objectives.

3. Project Organization (Appendix A, Paragraph B and Figure A-1)

State who is responsible for the specific application and give a brief description of the organizational structure.

4. Test Plan and Schedule (Appendix A, Paragraph C and Figure A-2)

Describe in simple milestone format how the application is progressing toward meeting its goals.

5. Functional Description (Appendix A, Paragraph D and Figure A-3)

Describe the operation of the system with a functional block diagram showing inputs/outputs of each subsystem under a specific set of operating conditions; e.g., insolation level, NOCT, etc.

6. System Operation, Procedure (Appendix A, Paragraph E)

Summarize the type and frequency of review, tests, or checks made to verify/satisfy:

(1) System performance.

(2) Reliability.

(3) Maintenance.

(4) Safety.

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Discuss test results to date, including any drop in performance and the reasons therefore.

Describe the procedures used in a typical day of operation.

7. Resources (Appendix A, Paragraph F)

Briefly summarize the resources required for managing the operation. Give a yearly breakdown of manpower required and total dollars expended. Remember to use 1980 dollars.

B. TEST AND APPLICATIONS INFORMATION (APPENDIX B - F WORKSHEETS)

1. General

The objective of the T&A subprogram as defined in the MYPP is to obtain operational information from photovoltaic systems. The information required falls into five categories.

(1) Performance.

(2) Costs.

(3) Reliability.

(4) Safety.

(5) Socio-environmental data.

2. Performance (Appendix B Worksheets)

The purpose of obtaining this information is two-fold:

(1) To determine the specified nameplate capacity of the photovoltaic array and system and compare it with verified values of capacity and

(2) To determine the energy efficiency of the array and system.

a. Assumed Name-Plate D.C. Capacity of Array (Appendix B, Paragraph A). Describe how the rating was arrived at in terms of specified module power output under a set of specified conditions. What document(s) specify module performance?

b. Assumed Name-Plate Capacity of System (Appendix B, Paragraph B). Describe how this rating was determined in terms of the specified or estimated efficiencies of subsystems other than the photovoltaic array. What document(s) specify system performance?

c. Verified Name-Plate D.C. Capacity of Array (Appendix B, Paragraph C). Describe how the measurements were taken, the measurement points, types of instruments used and tolerances. Also describe state of cleanliness of modules, and when last cleaned. To incorporate as much consistency as possible for getting measurements, the following procedure is recommended:

Take all measurements during local solar noon* (±20 minutes) for the particular site. At the time of readings make certain that the sun is not obscured. Take readings for a period of several days as a check on measurement reliability.

Use the system block diagram to identify points of measurements. Normalize the measured array output to Standard Operating Conditions to obtain the name-plate capacity.

d. Verified Name-Plate Capacity of System (Appendix B, Paragraph D). These measurements should be taken at the output of the power conditioner or at the load input at the same time the array output measurements are taken. Describe how the measurements were taken, measurement points, type of instruments used and tolerances. Account for all subsystem losses and specify where they occur.

c. Energy Efficiency (Appendix B, Paragraph E). Summarize, by month, the D.C. electrical energy output of the array field and, if applicable, the A.C. output of the power conditioning subsystem. Summarize, by month, the solar radiation energy incident upon the array field and the manner in which it was determined. Compute the monthly array and system efficiencies. Credit the system efficiency with any useful thermal output.

3. Costs (Appendix C Cost Worksheet)

The purpose of obtaining cost information is to identify subsystem cost elements and the magnitude of their contributions. This information will be used to identify areas for future programmatic attention.

Whenever cost data is related to dollars per watts, the data must be derived using verified measurements of capacity in peak watts. All dollars are 1980 dollars and derived as shown in Appendix C.

Costs should be reported in two major categories: Initial capital cost in dollars per peak watt, and operation and maintenance expenses in dollars per peak watt per year. The "per year" element

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*Local solar noon is defined as that time when the real sun is on the local meridian.

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will be for the actual year, or if the site is not yet one year old, a projection based upon real data is acceptable. The assumptions for the projection must be listed. The sources of all cost data must be given.

4. Reliability (Appendix D Worksheets)

This audit function is required to determine if the appropriate data for evaluating the reliability of an application is being gathered. The intent is to obtain data which will be used to identify and categorize problems/conditions that degrade system performance.

a. System Level Reliability Data (Appendix D, Paragraph A). Determination of system reliability is dependent upon how often the system is checked and what allowances for performance deviation have been made. Performance information should be recorded along with all corrective actions taken.

b. Subsystem/Component Level Reliability Data (Appendix D, Paragraph B). Subsystem/component failures may not measurably impact initial system performance, but such information is vital in system reliability predictions. Therefore, records of failures and problems must be recorded.

c. Feedback/Corrective Action (Appendix D, Paragraph C). Effective control of an application requires the monitoring of its performance against its goals. The feedback process depends on what is being controlled and the frequency of its measurement. Show how problem/failure information is being used to determine corrective action and how the corrective action is initiated.

5. Safety (Appendix E Worksheets)

The purpose of obtaining this information is to establish that a photovoltaic application safety program does exist and is in conformance with all applicable regulations, code standards, and specifications.

The audit format will be broken into the two major areas of equipment and personnel safety measures. The site safety plan should include: a hazard checklist; a detailed schedule showing inspection periods and corrective action response times; rules for enforcement of regulations at the site; methods of keeping records and routing information on safety problems to the TD&A Lead Center.

a. Personnel Safety (Appendix E, Paragraph A). Indicate whether a personnel safety plan has been written and, if so, how it is

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enforced. Identify all hazardous areas at the site and what methods are in use to protect personnel.

List the specific procedures used in maintenance and point out how these alert personnel to various hazards. Point out where a "buddy system" is required and used, methods/frequency of safety training, and emergency drills.

b. Equipment Safety (Appendix E, Paragraph B). Identify the safety plan which specifically deals with equipment or hardware safety. Start at the system/site level and point out how the site operator maintains the status of equipment safety.

6. Socio-Environmental Data (Appendix F Worksheets)

The aim of this portion of the audit is to gather information on the sensitivity of experiments as related to local physical and social environments. There are two aspects to be considered; one is the impact the local environment is having on the experiment, the other is the impact the experiment is having on the local environment.

a. Environmental Exposure Information (Appendix F, Paragraph A). The major element of the audit includes measured and observed determination of the physical environmental exposure. Although the performance section of the audit will supply PV system output data, possible reasons/explanations for particular performance characteristics will be assessed. Environmental exposure data sheets will provide this backup information.

b. Institutional Conformance (Appendix F, Paragraph B). This portion of the audit will be conducted through interview with site users/owners. Topics to be considered are:

(1) Solar access.

(2) Zoning.

(3) Insurance and liability.

(4) Community/regional support.

(5) User acceptance.

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c. Photovoltaic System Impact on the Environment (Appendix F, Paragraph C).

(1) Soil.

(2) Species.

(3) Air quality.

(4) Waste disposal.

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APPENDIXES - AUDIT DATA SHEETS

GENERAL AUDIT INFORMATION

SITE IDENTIFICATION _____

OPERATIONAL DATE _____

LOCATION _____

SITE LATITUDE, ALTITUDE _____

COGNIZANT FIELD CENTER _____

SYSTEM CONTRACTOR _____

SITE OPERATOR _____

AUDIT DATE/PERIOD _____

AUDIT INFORMATION
FURNISHED BY: _____

APPENDIX A

EXPERIMENT/APPLICATION DESCRIPTION

(AUDIT FROM APPLICATION MANAGER'S POINT OF VIEW)

A. OBJECTIVES

Describe in specific terms what this application is supposed to accomplish as you (manager/user/owner) perceive it.

B. PROJECT ORGANIZATION

Use worksheet Figure A-1 to describe areas of responsibilities.

C. TEST PLAN AND SCHEDULE

Describe in simple milestone format how the application is progressing toward meeting its goals.

Use worksheet Figure A-2 for milestone layout. Refer to Figure A-1 for the milestone categories outlined under each task.

D. FUNCTIONAL DESCRIPTION

Describe the operation of the system with a functional block diagram showing inputs/outputs of each subsystem under a specific set of operating conditions. Prepare worksheet Figure A-3.

(Show organizational chart. Delineate to lowest level of operation.)

Figure A-1. Organizational Structure - Responsibilities

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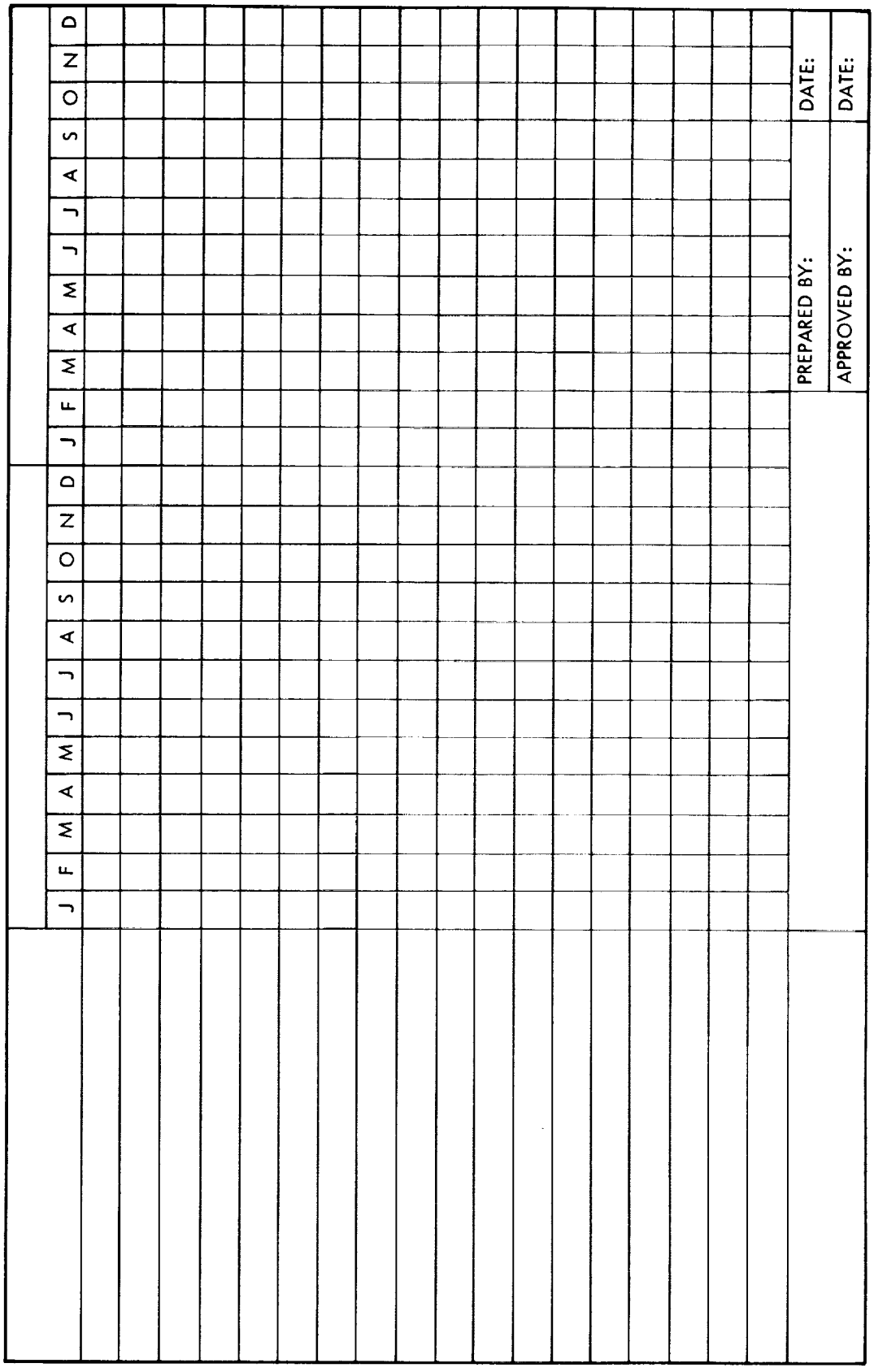

Figure A-2. Two-Year Schedule Worksheet

(Show subsystems, inputs, outputs, measurement points, etc.)

Figure A-3. Functional Block Diagram

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E. SYSTEM OPERATION, PROCEDURE

1. Summarize the type and frequency of review, tests or checks made to verify/satisfy:

a. System Performance: _____

b. Reliability: _____

c. Maintenance: _____

d. Safety: _____

2. Discuss test results to date, including any drop in performance and the reasons therefore.

3. Describe the procedures used in a typical day of operation:

F. RESOURCES

Prepare a convenient summary of the resources required for the operation of the site. Resource information should include a breakdown of labor in man-months per month and where the labor is applied. It should also include total dollars (1980$) obligated on a monthly basis. Any format is acceptable; provide your own worksheet.

APPENDIX B

TEST AND APPLICATIONS INFORMATION — PERFORMANCE

A. ASSUMED NAME-PLATE D.C. CAPACITY OF ARRAY, P_{AA} (TWO METHODS OF DERIVATION)

1. As specified in Document _____

   Document Name-Plate _____ kW at _____ mW/cm^2 insolation

   level at _____ °C cell temperature and air mass _____

2. As derived from module performance data, Document _____

   (a) Maximum Power (W_{MP}) _____ (Watts)

   (b) Voltage at Maximum Power (V_{MP}) _____ (Volts)

   (c) Current at Maximum Power (I_{MP}) _____ (Amps)

   Derived under specified conditions of insolation _____ (mW/cm^2)

   (mW/cm^2) and Cell Temp. _____ (°C)

   According to the formula:

$$P_{AA} = \Sigma W_{MP} = \Sigma V_{MP} \times \Sigma I_{MP} = \text{WATTS} \qquad (1)$$

where

ΣW_{MP} is the sum of all the individual module powers

ΣV_{MP} is the sum of all the module volts wired in series to meet the system voltage requirements

ΣI_{MP} is the sum of all the module amps wired in parallel to meet the system current requirements

B. ASSUMED NAME-PLATE CAPACITY OF SYSTEM, P_{SA} (TWO METHODS OF DERIVATION)

(1) As specified in Document _____

As _____ kW located at _____

(Describe location where system output is specified)

(2) As derived by analysis or by use of equation (2) to correct P_{AA} for assumed subsystem efficiencies or losses identified below.

Loss	Assumed Efficiency (η)
Module Mismatch	
Dirt Accumulation	
DC Wiring	
Battery In/Out	
Inverter	
AC Wiring	
Tracking	
Cumulative η_{CUM}	

Therefore,

$$P_{SA} = P_{AA} \times \eta_{CUM} = \_\_\_\_\_ (kW) \qquad (2)$$

C. VERIFIED NAME-PLATE D.C. CAPACITY OF ARRAY, P_{AV}

This is to be accomplished by measuring array output (P_{AM}) under unobscured sun conditions at solar noon* ±20 minutes. This power measurement is then to be adjusted or normalized to a power output (P_{AV}) that could be expected for Standard Operating Conditons (SOC). A worksheet for recording the necessary data is provided in Table B-1.

*Solar Noon is defined as the time when the real sun is on the local meridian.

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Table B-1. Worksheet for Photovoltaic System Measurements

MEASUREMENT LOCATION * AND NUMBER	DATE	LOCAL TIME	ELECTRICAL MEASUREMENTS			MEASURED INSOLATION IN PLANE OF ARRAY IN (MW/cm^2)	AMBIENT AIR TEMP (°C)	AVERAGE SOLAR CELL TEMP T_{cm} (°C)	REMARKS
			V (VOLTS)	I (AMPS)	POWER (WATTS)				
ARRAY OUTPUT P_{AM} (1) (2) (3)									
CONDITIONED OUTPUT TO LOAD P_L (1) (2) (3)									
_____ (1) (2) (3)									
_____ (1) (2) (3)									
_____ (1) (2) (3)									

* SEVERAL MEASUREMENTS OVER SEVERAL DAYS RECOMMENDED WITH THE DATA BEARING SAME NUMBER AS SIMULTANEOUS AS POSSIBLE.

ADDITIONAL INFORMATION

(1) COLLECTOR TYPE: FLAT PANEL OR CONCENTRATOR
(2) COLLECTOR NOCT OR EQUIVALENT: _____ °C
(3) SOLAR CELL POWER/TEMP. COEFFICIENT ($\Delta P/\Delta T$)_____ /°C

The method of normalizing P_{AM} to P_{AV} can be accomplished by one of three methods:

(1) Comprehensively defined current and voltage temperature coefficients for the solar cells being used.

(2) Interpolation of array test data.

(3) Mathematical modeling of array behavior as a function of cell temperature and insolation.

The particular method used is left to the discretion of the experimenter. The only mandatory requirement is that P_{AV} be expressed in terms of S. O. C., which is defined as 100 mW/cm^2 irradiance and a cell temperature equal to the nominal operating cell temperature (NOCT) for flat panel collectors or its equivalent for concentrating collectors.

D. VERIFIED NAME-PLATE CAPACITY OF SYSTEM (P_{SV})

For determination of verified system capacity under S.O.C., measurement of the power delivered to the load (P_L) will be taken either at the array output bus for a DC system or, for AC systems, at the inverter output.

With the assumption that P_{SV} is proportional to P_{AV},

$$P_{SV} = \frac{P_{AV} \times P_L}{P_{AM}} \qquad (4)$$

Note that for a DC system, the power delivered to the load (P_L) is equivalent to the array output bus measurement (P_{AM}) adjusted for any power conditioning.

Summarize the assumed capacities, the measurements from Table B-1, and the computed, verified capacities in the format provided in Table B-2.

Table B-2. Summary of Assumed/Verified Capacity

MEASUREMENT NO. DATE	ASSUMED CAPACITY (W)		MEASURED POWER (W) FROM TABLE B-1		COMPUTED, VERIFIED CAPACITY (W)	
	OF ARRAY P_{AA}	OF SYSTEM P_{AS}	ARRAY OUTPUT P_{AM}	TO LOAD P_L	OF ARRAY P_{AV}	OF SYSTEM P_{SV}

E. ENERGY EFFICIENCY

MONTH	① DC OUTPUT OF ARRAY FIELD (KWH)	② ELECTRICAL OUTPUT TO LOAD (KWH)	③ INSOLATION INCIDENT UPON ARRAY FIELD (KWH)	PV SYSTEM ONLY		PV + THERMAL	
				ARRAY EFFICIENCY ①/③	SYSTEM EFFICIENCY ②/③	④ EQUIV. ELEC. OFFSET BY THERMAL OUTPUT (KWH)	SYSTEM EFFICIENCY (② + ④)/③

How were energy measurements made? _____

APPENDIX C

TEST AND APPLICATIONS INFORMATION — COST

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Table C-1. Derivation of Installed System Price and Operations and Maintenance Costs

SYSTEM COST ELEMENT		INITIAL CAPITAL COST, $/Wp (1980 $) ①				O&M COSTS ⑤ $/Wp (1980$)	DEFINITIONS OF TERMS
		FOB MFR ②	M & D ③	INSTALL-ATION ④	SUBTOTAL		
ARRAY	● COLLECTOR						① TO DERIVE 1980$ FOR FUTURE YEARS, USE A PRICE DEFLATOR OF 8%. TO CONVERT PRIOR YEARS, USE INFLATOR OF: 1976 (5.2%), 1977 (5.9%), 1978 (7.4%), 1979 (8.8%) 1980 (8.0%). Wp IS THE VERIFIED NAME-PLATE CAPACITY OF THE SYSTEM.
	● STRUCTURES AND FOUNDATIONS						
	● SITE AND PREPARATION						
	● FIELD WIRING						
	● LIGHTNING PROTECTION						
POWER PROCESSOR	● POWER CONDITIONER						② F.O.B. MANUFACTURER: PRICE PAID AT THE LOADING DOCK OF THE MANUFACTURER.
	● ELECTRICAL DIST. AND CONTROL						
	● CONTROL BLDG						③ MARKETING AND DISTRIBUTION: ADVERTISING, SALES, TRANSPORTATION (MFR TO DISTRIBUTOR TO SITE), WAREHOUSE EXPENSE, PROFIT TO DISTRIBUTOR.
STORAGE	● BATTERY						
	● CHARGER						④ INSTALLATION: ALL CONTRACTOR SITE WORK NECESSARY TO INSTALL SYSTEM INCLUDING LABOR, MATERIALS, SITE PREPARATION, AND CONTRACTOR PROFIT.
	● BATTERY BLDG						
INDIRECTS	● DESIGN & PROJECT MGMT FEE	X	X	X		X	⑤ OPERATIONS AND MAINTENANCE: RECURRING COSTS INCLUDING OPERATION STAFF, SCHEDULED/UNSCHEDULED MAINTENANCE, EQUIPMENT REPLACEMENT, ROUTINE PERFORMANCE EVALUATION, SPECIAL TROUBLESHOOTING, ETC.
	● SALES FEE						
	● INTEREST DURING CONSTRUCTION						
TOTALS							

INSTALLED SYSTEM PRICE

APPENDIX D

TEST AND APPLICATIONS INFORMATION – RELIABILITY

A. SYSTEM LEVEL

1. How often is system capacity compared to rated? _____

_____

2. What percent deviation is allowed? _____

3. When are physical/visual examinations conducted? _____

_____

4. Does the log book make notation of the following: (Yes, No)

   (1) Number of forced outages/dates/causes? _____

   (2) Length of time for each outage? _____

   (3) System output degradation/trends/causes? _____

   (4) Unscheduled maintenance/reasons? _____

B. SUBSYSTEM/COMPONENT LEVEL (Use Worksheet Table D-1)

   (1) ID: The subsystem or component will be identified by Mfg. model.

   (2) Type of Failure will be classed as to mechanical, electrical, damaged by impact, overload, corrosion, etc.

   (3) Operating Time means length of time the part has been in the PV system plus any other known operational exposure.

   (4) Down Time is that length of time the system performance was impaired or system was shut down due to the part failure. The audit will be limited to this level of failure data. Details for in-depth analysis of each component/item are not a function of this audit.

Table D-1. Subsystem Failure Log Worksheet

SUBSYSTEM		① ID	NO. FAILURES	② TYPE FAILURE	③ OPERATING TIME	④ DOWN TIME
ARRAY	• COLLECTOR • STRUCTURES AND FOUNDATIONS • FIELD WIRING • LIGHTNING PROTECTION					
POWER PROCESSOR	• POWER CONDITIONER • DISTRIBUTION • CONTROL					
STORAGE	• BATTERY • CHARGER					

C. FEEDBACK/CORRECTIVE ACTION

Explain what methods of problem-failure reporting and record keeping are used.

(1) Are log books being kept? _____

(2) Are log books reviewed and by whom? _____

(3) Do log books reference problem/failure reports? _____

(4) Is a failure reporting system being used? _____

(5) If corrective action is needed, how does it occur? _____

_____

_____

_____

_____

(6) Who makes the decision that corrective action is needed? ____

_____

_____

(7) What steps are taken to assure that corrective action has occurred? _____

_____

_____

_____

(8) If new standards of performance result from the action, where are they recorded? _____

_____

_____

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APPENDIX E

TEST AND APPLICATIONS INFORMATION – SAFETY

A. PERSONNEL SAFETY

1. Do any operations require a buddy system? _____

List them: _____

_____

_____

How is the buddy system policed? _____

_____

_____

2. Are hazardous areas marked and explained? _____

3. Are hazardous areas enclosed? _____

(1) Fencing _____

(2) Locks _____

(3) How is access controlled? _____

_____

_____

4. Are smoke/fume detectors operating? _____

(1) Do personnel know what the alarm signifies? _____

5. Have fire extinguishers been classified and dispersed by a recognized authority? _____ Who? _____

6. Status of personnel safety records (for period being audited):

INJURY	TYPE	DAYS LOST	HOW DID IT OCCUR

UNUSUAL INCIDENTS (Near Misses)

A copy of each Unusual Incident Report is to be furnished. It should include:

(1) How and when the incident occurred

(2) What the potential outcome might have been

(3) Steps taken to avoid the type of incident in the future.

B. EQUIPMENT SAFETY

1. Have operating procedures been prepared for all site operational functions? _____

1. How is the use of procedures enforced? _____

_____

_____

3. How often are system alarms and emergency switching checked? _____

_____

4. Are they all presently working? _____

5. Does system have lightning protection installed? _____

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C. EQUIPMENT AND PERSONNEL DATA

1. Does a written safety plan exist? _____

2. Does the plan include a hazard checklist? _____

3. How is the plan implemented? _____

(1) Safety representative (NAME) _____

(2) Link to management (DESCRIBE) _____

_____

_____

_____

(3) How often are safety inspections performed? _____

(4) Who gets the review information? _____

(5) Are safety meetings held? _____

(6) Who must attend? _____

_____

_____

(7) How are safety rules enforced? _____

_____

_____

(8) Are safety exercises/drills called for? _____

(9) How often? _____

(10) Are personnel trained in basic safety/emergency procedures?

_____

(11) Are safety records kept? _____

(12) Location (distance) of nearest fire station? _____

_____

4. How often are continuity checks made between all conductive load surfaces and grounding point? _____

5. Does the power conditioning provide a positive disconnect of the solar system (or utility) or both? _____

6. Is system provided with array/module disconnects at 50 V maximum stages for safe maintenance? _____

7. Is array within sight of (visible from) distribution box? _____

8. If not, is there a disconnect at the array? _____

9. Is ventilation adequate in all rooms where outgassing is prevalent?

_____

10. Are general safety items available in areas where needed (face mask, gloves, acid neutralizers, emergency breathing apparatus)?

_____

APPENDIX F

TEST AND APPLICATIONS INFORMATION — SOCIO-ENVIRONMENTAL DATA

A. ENVIRONMENTAL EXPOSURE

This will be used to provide additional information regarding any adverse influence on site performance.

1. Severe Events

Thunderstorms	_____days/mo.
Hail storms	_____days/mo.
Ice storms	_____days/mo.
Tornadoes	_____days/mo.

B. INSTITUTIONAL CONFORMANCE

This portion of the audit will be conducted through interview with site users/owners. Topics to be considered are:

1. Solar Access

Has any construction, growth or surrounding land interfered with planned solar access?

2. Zoning

Have any circumstances arisen which conflict with local ordinances? Is the experiment demonstrating compatibility with surrounding land use?

3. Insurance and Liability

Is the site presently insured? Have there been any liability claims?

4. Community/Regional Support

Is there any positive proof of community support? Conversely, is there a record of any public/group agitation about the site? Have any complaints been received from local jurisdictional bodies, building departments or homeowner organizations?

5. User Acceptance (Homeowner, Operator, Utility)

Does the user (homeowner, operator, utility) have any specific problems or complaints? What is the user's level of satisfaction?

C. PHOTOVOLTAIC SYSTEM IMPACT ON THE ENVIRONMENT

1. Soil

Has the site in any way impacted off-site soil and vegetation? How?

2. Species

Is there any evidence (observed or presented) that the site has impacted wildlife habitat or endangered species?

3. Air Quality

Is local air quality managed by local authorities? Is the site air quality managed/monitored by the site operations authority? Has any outgassing of photovoltaic equipment been observed? What types? How measured?

4. Waste Disposal

How is waste water disposed of (cooling system drainage, array washing)? What is the method(s) for disposing of general trash, used equipment, batteries, acids? Do procedures exist? Do they comply with local and jurisdictional guidelines?